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INFORMAL EXAMINER'S AMENDMENT

ABSTRACT OF THE DISCLOSURE

The present invention describes nanophotonic materials and devices for both classical and quantum optical signal processing, transmission, amplification, and generation of light, which are based on a set of quantum systems having a discrete energy levels, such as atoms, molecules, or quantum dots, embedded in a frequency bandgap medium, such as artificial photonic crystals (photonic bandgap materials) or natural frequency dispersive media, such as ionic crystals, molecular crystals, or semiconductors, exhibiting a frequency (photonic) bandgap for propagating electromagnetic modes coupled to optical transitions in the quantum systems. If the frequency of one of optical transitions, called the working transition, lies inside the frequency bandgap of the medium, then spontaneous decay of the working transition into propagating photon modes is completely suppressed. Moreover, the excitation of the working transition and a photon form a photon-quantum system bound state lying inside the photonic bandgap of the medium, in which radiation is localized in the vicinity of the quantum system. In a quantum system "wire" or a quantum system "waveguide", made of spatially disordered quantum systems, or in a chain quantum system waveguide made of a periodically ordered identical quantum systems, wave functions of the photon-quantum system bound states localized on different quantum systems overlap each other and develop a photonic passband lying inside bandgap of the photonic bandgap medium. ~~Photons with frequencies lying inside the photonic passband propagate along the quantum system waveguide. Since the working transition cannot be excited twice, the passband photons interact with each other extremely strongly both in one waveguide and in different waveguides that are located sufficiently close to each other. These unique nonlinear properties of the quantum system waveguides are proposed to use for engineering key nanophotonic devices, such as all-optical and electro-optical switches, modulators, transistors,~~

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~~control NOT logic gates, nonlinear directional couplers, electro-optical modulators and converters, generators of entangled photon states, passband optical amplifiers and lasers, as well as all-optical integrated circuits for both classical and quantum optical signal processing, including quantum computing.~~